Trauma Analysis

1 Scope

The following procedures are for describing, recording, and interpreting skeletal trauma by Anthropology Examiners within the Trace Evidence Unit (TEU). The terms in this section are defined as they apply to forensic anthropology, and may differ from terminology used in other disciplines/categories of testing.

2 Equipment/Materials/Reagents

- Sliding calipers capable of measuring items up to 200mm within +/- 0.5mm (Mitutoyo Digimatic Absolute Digital Calipers 500-172-20 CD-8”CX or equivalent)
- Spreading calipers (digital or analog) capable of measuring items up to 300mm within +/- 0.5mm (Paleo-Tech Digital Linear Spreading Calipers with Mitutoyo Digimatic Absolute Digital Scale 572-213-10 or equivalent)
- Digitalradiography unit (NorthStar X-5000 Digital X-radiography unit or Kubtek radiography unit or equivalent)
- Personal protective equipment (e.g., lab coat, gloves, eye protection)
- Digital camera (Nikon D70 or equivalent)
- Tape measure
- Stereobinocular microscope, magnification range from 0.5x to at least 40x
- Sandbox (capable of accommodating and stabilizing human bones and fragments)
- Sand
- Wooden struts
- Reversible adhesive (Paraloid B-72 or equivalent)
- Permanent adhesive (cyanoacrylate or equivalent)

3 Standards and Controls

Not applicable.

4 Sampling

Not applicable.

5 Procedure

The Forensic Anthropological Examinations Procedure will be followed. Trauma is injury or disruption of living tissue by an outside force. The analysis of trauma requires the application of

elements of physics, biomechanics, materials engineering, ballistics, taphonomy, anatomy, and osteology.

Analysis of trauma will involve careful observation, thorough documentation, and interpretations will be based on scientifically valid methods and principles. A trauma analysis is typically performed by macroscopic, microscopic, and/or radiologic examination of the remains for evidence of traumatic alteration. Where possible, the examiner will attempt to assess the timing as well as the mechanism of trauma. Additionally, the examiner will describe postmortem alterations to the material.

5.1 Procedures for Classifying Trauma Timing

Characteristics and morphology of the alteration are used to determine when the trauma occurred relative to the death of the individual. Trauma timing may be classified as antemortem, perimortem, or postmortem

For the classification of trauma timing, the alteration will be examined visually. Examination may also include the use of a low magnification microscope and/or radiological analysis.

5.1.1 Antemortem Trauma

Antemortem trauma refers to an injury occurring prior to an individual's death. Antemortem trauma is classified on the basis of evidence of osteological activity in response to an injury. Features indicative of antemortem trauma include:

- Healed or healing fractures
- Pseudoarthrosis
- Trauma-induced degenerative joint disease
- Infectious response
- Surgically implanted devices.

5.1.2 Perimortem Trauma

Perimortem trauma refers to an injury occurring around the time of death, and when the skeletal tissue is in a biomechanically fresh state. Perimortem timing of trauma in anthropological examinations is classified on the basis of evidence of the biomechanical characteristics of fresh bone regardless of the temporal relationship to the actual death event. Trauma classified as perimortem may occur substantially after the death event and may be unrelated to the death event. Features indicative of perimortem trauma include:

- A lack of healing or infectious response
- Fresh bone fracture characteristics (e.g., plastic response)
- The absence of dry bone fracture characteristics (e.g., angular fractures)
- An overall fracture pattern characteristic of a terminal event (e.g., rapid deceleration event)

5.1.3 Postmortem Alterations

Postmortem alteration refers to taphonomic changes to bone after the individual's death and that are unassociated to the death event. Features indicative of postmortem alteration include:

- Differentially stained or recently exposed surfaces
- A lack of healing
- A lack of fresh bone fracture characteristics (e.g., plastic response)
- Pattern of damage (e.g., pitting, scoring and missing bone consistent with scavenging)

5.2 Procedures for Classifying Trauma Mechanism

For the classification of trauma mechanism, the alteration(s) will be examined using sufficient ambient and directed lighting. In some cases, low magnification microscopy and radiography will be used. When sufficient alterations are present, trauma may be classified as resulting from forces including blunt, sharp, high velocity projectile, or thermal exposure. Observed trauma patterns may be compared to literature or other reference material to aid in classification of mechanism. The following examinations will be performed, where applicable and appropriate, when assessing trauma mechanism:

- Examine and photograph fractured or incised surfaces.
- Examine cartilage for the presence of alterations prior to removal of soft tissues.
- Reconstruct fractured areas.
- Record alteration sites and provide descriptions, minimum and maximum measurements, and anatomic location. Measurements will be taken using calipers or a tape measure.
- Record the appearance and pattern of trauma with regard to fractures, missing bone, color changes, or other alterations.
- Estimate the minimum number and sequence of injuries, if possible. These are determined by the number of identifiable impact sites, and the intersections of fractures.
- Record the characteristics of the striking surface (e.g., circular, flat surface).
- Indicate the direction or orientation of the force or travel of projectiles relative to anatomy.
- Record whether projectile alterations are entry or exit sites based on the presence and direction of beveling.
- Look for linkages between articulated or localized bones to clarify possible patterns.
- Record intrusive materials or substances left by a tool when present at an impact site (e.g., hair trapped in bone) as well as any other associated evidence (e.g., soot or residue that may have been discharged from a gun).

5.2.1 Blunt Trauma

Blunt trauma is produced by low velocity impact from a blunt object (e.g., beating, motor vehicle accident, concussive wave) or the low velocity impact of a body with a blunt surface (e.g., fall). Features indicative of blunt trauma include:

- Plastic deformation
- Delamination
- Fracture pattern indicating a low velocity impact site
- Location and characteristics of known clinical fractures (e.g., parry, Colles, tea cup, or overall patterns seen in auto collisions or falls from heights)
- Fractures in contiguous or anatomically related bones
- Tool marks or impressions indicating an impact site
- Beveling of concentric fractures in the cranial vault that indicate an external to internal force

5.2.2 Sharp Trauma

Sharp trauma occurs from edged, pointed or beveled objects striking or penetrating a bone. Features indicative of sharp trauma include:

- Straight line incised alterations
- Punctures or gouges
- Chop or hack marks (clefts)
- Kerfs

5.2.3 High-Velocity Projectile Trauma

High-velocity projectile trauma is produced by impact from a projectile (e.g., gunshot, explosive-related) traveling at a high rate of speed. Features indicative of high-velocity projectile trauma include:

- The presence of a projectile in association with the bone
- Projectile entrance or exit characteristics
- The presence of residue, wipe, or remnants of the projectile present visually or radiographically
- Fracture patterns indicating a high velocity impact site
- Beveling of concentric fractures in bones of the cranial vault that indicate an internal to external force

5.2.4 Thermal Alteration

Thermal alteration to bone is produced by high temperature or direct contact with flame. Features indicative of thermal alteration include:

- Color changes (e.g., yellow, black, white)
- Delamination

- Burn pattern
- Shrinkage
- Charring or calcinations
- Fractures

5.3 Records

5.3.1 Case Notes

Documentation of trauma will include descriptive text, photographs, diagrams and radiologic images, as applicable. The case notes will include, when determined, the classification of timing and mechanism of trauma, and observations leading to these conclusions including references to literature or other materials. The location and characteristics of the trauma will be described using measurements and standard anthropological and anatomical terminology. Alterations will be recorded on diagrams and/or in written descriptions. Other information such as direction and sequence will be recorded as appropriate, including the patterns or evidence to support the conclusion.

5.3.2 Reports

The FBI *Laboratory Report* (7-1, 7-1 LIMS) will include the assessed timing and mechanism of trauma, as well as other information including directionality and sequence, if determined. When a distinction cannot be made between antemortem, perimortem, or postmortem, this will be clearly stated.

For example:

- *"An antemortem (healed, before the time of death) fracture is present on Item 1."*
- *"The alterations on Item 3 are consistent with a perimortem (around the time of death) projectile injury, entering on the left side and exiting on the right."*
- *"The alterations on Item 5 are consistent with postmortem (after the time of death) carnivore scavenging."*
- "*The timing of the skeletal trauma could not be determined.*"

6 Calculations

Not applicable.

7 Measurement Uncertainty

7.1 The measurement uncertainty with calipers is approximately ± 0.02 mm or better, depending on the caliper used. Refer to instrument manuals for uncertainty for a particular caliper. This degree of measurement uncertainty does not significantly affect anthropological conclusions and is not detrimental to the results of anthropological examinations.

7.2 The measurement uncertainty with an osteometric board is approximately ± 0.5 mm. This degree of measurement uncertainty does not significantly affect anthropological conclusions and is not detrimental to the results of anthropological examinations.

8 Limitations

The conclusions that can be reached from anthropological examinations assessing the timing and mechanism of skeletal trauma are dependent on the condition and completeness of the remains. Results based on fragmentary or poorly preserved material may be inconclusive.

Studies of skeletal trauma have revealed patterns that are governed by bone biomechanical properties and show relationships with certain known causes. However, due to the variety and complexity of factors that may contribute to disruption of skeletal tissues, it is not always possible to determine trauma mechanism or timing with certainty.

9 Safety

9.1 While working with physical evidence, laboratory personnel will wear at least the minimum appropriate protective attire (e.g., laboratory coat, safety glasses, protective gloves).

9.2 Universal precautions will be followed.

9.3 Exposure to biological and radiological hazards may be associated with the examination techniques performed. Safety procedures related to specific instruments or equipment (e.g., X-ray units) will be followed. Refer to the FBI Laboratory Safety Manual for guidance.

10 References

- Forensic Anthropological Examinations, Trace Evidence Procedures Manual (current version)
- Digital Radiography, Chemistry Unit, Metallurgy (current version)
- FBI Laboratory Safety Manual (current version)
- Scientific Working Group for Forensic Anthropology guidelines for Trauma Analysis (current version)

Rev. #	Issue Date	History
1	02/05/2018	Updated throughout removing references to TEU where appropriate; added forensic anthropologists to the Scope in Section 1 and Section 5. Updated Section 2. Removed Section 4 Calibration and renumbered. Added 'or Sample Selection' to new Section 4 title. Updated Sections 5, 5.1, 5.1.2, 5.1.3, 5.2, 5.2.1, 5.2.2, 5.3, 5.3.2, and Sections 7 for clarity. Updated references in Section 10.
2	02/10/2020	Changed 'forensic anthropologist' to 'Anthropology Examiner' in Scope and 'examiner' throughout. Removed 'Sample Selection' from Section 4 title. Replaced 'trauma' with 'alteration' in Section 5.2.4.

Approval

Redacted - Signatures on File

Trace Evidence Unit Chief — Date: 02/07/2020

Anthropology Technical Leader — Date: 02/07/2020